The Middle Triassic Megafossil Flora of the Basin Creek Formation, Nymboida Coal Measures, New South Wales, Australia. Part 8. The Genera *Nilssonia*, *Taeniopteris*, *Linguifolium*, *Gontriglossa* and *Scoresbya*

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Ten taxa of simple leaves in the genera *Nilssonia*, *Taeniopteris*, *Linguifolium* and *Gontriglossa* and a lobed leaf in the genus *Scoresbya* are described from two quarries in the Middle Triassic Nymboida Coal Measures of the Nymboida sub-Basin in north-eastern New South Wales. The new species *Nilssonia dissita* and *Taeniopteris aduncа* are based on previously unpublished material from Queensland together with conspecific material from Nymboida. An additional four new species from Nymboida are described; *Taeniopteris nymboidensis*, *Linguifolium parvum*, *Gontriglossa ligulata* and *Scoresbya carsburgii*.

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KEYWORDS: Middle Triassic flora, Nymboida Coal Measures, palaeobotany, simple fossil leaves.

INTRODUCTION

This is the eighth paper of a series describing the early-middle Triassic Nymboida flora. Part 1 of this series (Holmes 2000) described the Bryophyta and Sphenophyta, Part 2 (Holmes 2001) the filicophyta, Part 3 (Holmes 2003) fern-like foliage, Part 4 (Holmes and Anderson 2005a) the genus *Dicroidium* and its fertile organs *Umkomasia* and *Pteruchus*, Part 5 (Holmes and Anderson 2005b) the genera *Lepidopteris, Kurtziana, Rochipteris* and *Walkomiopteris*, Part 6 (Holmes and Anderson 2007) the Ginkgophyta and Part 7 (Holmes and Anderson 2008) the Cycadophyta. In this paper the simple leaves in the genera *Nillsonia, Taeniopteris, Linguifolium* and *Gontriglossa* together with the enigmatic lobed leaf *Scoresbya carsburgii* are described.

A description of the Coal Mine and Reserve Quarries, the source localities of our described material together with a summary of the geology of the Basin Creek Formation, the Nymboida Coal Measures and the Nymboida Sub-Basin were provided in Holmes (2000).

METHODS

The material described in this paper is based mainly on collections made by the senior author and his family from two then-active Nymboida quarries (Coal Mine Quarry and Reserve Quarry) over a period of forty years. The specimens noted in Flint and Gould (1975), Retallack (1977), Retallack et al (1977) and Webb 1980 were examined in the collections of the Australian Museum, Sydney, the Department of Geology and Geophysics of the University of New England, Armidale and the Queensland Museum, Brisbane..

The University of Queensland PhD thesis on "Aspects of Palaeontology of Triassic Continental Sediments in South-East Queensland" by J.A.Webb (1980) included the descriptive taxonomy of fossils of simple leaves, similar to those that form the subject of this paper. In addition to his own extensive field collections Webb also examined all available and relevant material in State and private collections. Descriptive taxonomy in the past has so often been based on very limited and often fragmentary material. From Webb's extensive range of material it was possible to gain a better understanding of species boundaries through the natural range of variation occurring within the fossil populations. On the basis of floral similarities, the Esk Formation (Toogoolawah Group) of south-east Queensland and the Nymboida Coal Measures of north-east New South Wales were deposited contemporaneously in the Anisian-Ladinian (Flint and Gould 1977, Rigby 1977). Regrettably most of Webb's research was never published. Because of its relevance to this paper, two new species presented below are based on his original descriptions and types with Webb acknowledged as the author. Taxonomically comparable Nymboida specimens are illustrated and listed as "Additional Material".

Since the completion of the research by Webb (1980) new studies have been published on similar taxonomic groups from other Gondwana Triassic floras that are relevant to this paper. Retallack (1980) reviewed the Middle Triassic Tank Gully flora of New Zealand and proposed a new combination for *Linguifolium tennison-woodsii*; Artabe (1985) described six *Taeniopteris* species from Los Menucos Formation of Argentina; Anderson and Anderson (1989), in their taxonomic revision of the South African Molteno gymnosperms described and extensively illustrated nine species of *Taeniopteris,* five species of *Linguifolium* and three species of *Gontriglossa*; Gnaedinger and Herbst (1998) described three species of *Taeniopteris* and three species of *Linguifolium* from El Tranquilo Group of Argentina; Gnaedinger and Herbst (2004a) described ten species of *Taeniopteris* from northern Chile, using a statistical analysis of venation characters; Gnaedinger and Herbst (2004b) described one *Linguifolium* sp also from northern Chile and Herbst et al (2005) listed one *Taeniopteris* sp. and two *Linguifolium* spp from the Lake District of Chile.

The Nymboida specimens are preserved in mudstones, siltstones and sandstones as carbonaceous compressions or impressions in which the gross morphology is usually well-preserved. However spores and cuticles have been destroyed by a tectonic heating event during the Cretaceous Period (Russel 1994). Therefore our identification of taxa is based only on characters of gross morphology.

The exact stratigraphic horizon or detailed source of much of our Nymboida specimens is uncertain as most were collected from fallen blocks during quarry excavations. The Coal Mine Quarry has not been active for some twenty years but the high working face, although now rather weathered, provides an excellent exposure of beds that demonstrate the palaeo-environmental conditions at the time of deposition and was described by Retallack (1977). In 2006 the Reserve Quarry was bulldozed into a featureless bowl – "for restoration and safety purposes" and the fossiliferous horizons are now hidden.

The Nymboida material described in this paper has been allocated AMF numbers and is housed in the palaeontology collections of the Australian Museum, Sydney.

DESCRIPTIVE TAXONOMY

Without supporting cuticular evidence and lack of affiliation with any fertile structures for a definite systematic placement, the leaves described below are regarded as form genera in Gymnospermae – sedis incertae. On the basis of preserved cuticle *Nilssonia* leaves with haplocheilic stomata have been placed in the Cycadales and leaves of taeniopterid morphology may belong in several groups from ferns to cycads. Anderson and Anderson (2003) placed their Molteno *Taeniopteris* species in the Pentoxylales based on affiliation evidence and similarly they placed *Gontriglossa* in the Gnetopsida. The affinities of *Linguifolium* remain uncertain although Retallack (1980) suggested an affiliation with the seeds *Carpolithus mackayi*. *Scoresbya* has been speculated as being a fern, a seed fern, a member of the Caytoniales (Taylor and Taylor 2009) or even a pro-angiosperm (Weber 1995).

Gymnospermae incertae sedis
Genus *Nilssonia* Brongniart 1825

Type species

Nilssonia brevis Brongniart 1825

Nilssonia is a form genus that includes simple linear to oblanceolate leaves to irregularly pinnate leaves. It has a worldwide distribution and ranges from the Triassic to the Cretaceous. The main gross distinguishing character of the leaves is the dorsal attachment of the lamina which completely covers

the mid vein. The appearance of this character is often an artefact of preservation, eg the fossil may be an impression of the upper or lower leaf surface or an internal or external cast or mould that often masks the form and place of attachment of the lateral veins to the midrib.

The venation pattern of leaves from Gondwana localities differs somewhat from that of species described from the northern hemisphere in the more common bifurcation of the lateral veins and their straight and parallel course to the margin. Similar simple leaves in which the lamina does not completely cover the mid vein and without preserved cuticle are placed in the form genus *Taeniopteris*. Where cuticle information is available, the haplocheilic stomata and trichomes indicate cycadalean affinities. No cuticle is preserved on the Nymboida material. Some specimens in our Nymboida collections can be placed in a previously unpublished species as described by Webb (1980). Note this species is attributed to Webb.

Nilssonia dissita J.A.Webb sp. nov.

Figures 1A–C; 2A, B; 7A

Selected synonymy

1917 *Taeniopteris crassinervis* (Feistmantel) Walkom, p.38, Pl. 1, fig. 2.

1975 *Nilssonia* cf. *princeps* (Oldham and Morris) Seward; Flint and Gould, p.71.

1980 *Nilssonia dissita* Webb, p. 87, Pl.11, figs 3, 6, 8, Text figs 18 c, d (Unpubl.)

Diagnosis

Large simple leaf 65-150 mm wide; midrib 2.5–4 mm in width; lamina covers whole of mid-vein; secondary veins arise from the dorsal surface of a moderately wide central rib at fairly acute angle, then curve broadly to run at 80°–90° to margin; individual veins frequently bifurcate once, usually as they leave the central rib, occasionally fork a second time; density of venation 9–16 / 10 mm.

Description (revised to include new Nymboida material)

Leaves are simple, oblanceolate with undulate to entire margins and wavy to smooth surface, tapering to obtuse apex. Length from c. 200 to >300 mm, the leaf base is not known; width at mid lamina ranges from 60 –150 mm. Lamina is dorsally attached and completely covering the mid vein. Lateral veins diverging from a mid point above the mid vein at an angle of 50°–70°, arching to run at a high angle (70° – 90°) straight and parallel to the margin. Many veins bifurcate once, usually as they leave the central rib; a few subsequently fork a second time but never anastomose; veins coarse with a density 9–16 / 10 mm. Mid vein when exposed ranges in width from 1–4 mm.

Holotype

GSQ F12897

Type Locality

Geological Survey of Queensland Locality 1552, Esk Formation, Toogoolawah Group

Additional material

GSQ12898, Esk Fm. UNEF13443, AMF120989, AMF130180, AMF130181, AMF130182, AMF130183, all from Coal Mine Quarry, Nymboida CM. Also the material listed by Webb (1980), mostly from the Esk Formation of Queensland.

Name derivation

dissitus – Latin – *distant, apart,* referring to the widely spaced venation.

Discussion

Previous material from Nymboida (Flint and Gould, 1975) was recognised by Webb (1980) as questionably belonging to this species. From our new collections specimen AMF130180 is a block showing two leaves (Fig. 2B), one almost complete, preserved in almost three dimensions in white sandstone. The lamina of the more complete leaf, in places, completely covers the mid vein as can be seen by the lateral veins appearing to adjoin in mid lamina. The incomplete specimens AMF130182 (Fig. 2A) and AMF130183 both show sections of a leaf with adjoining lateral vein bases over the mid vein. In other parts of these leaves and similarly in the full length of AMF130181 (Fig.1C) the mid vein is exposed as an artefact of preservation. These leaves are included in this species based on the form, course and density of their veins and there being no evidence that the veins were laterally attached to the margin of the mid vein.

Nilssonia moretonii Walkom 1928

Figure 8A

Synonymy

1928 *Nilssonia moretonii* Walkom, p. 466, Pl. 25, figs 2, 3, 7.

1980 *Nilssonia moretonii* Walkom; Webb, Pl 10, figs 1, 4, 6, 7.

1989 *Taeniopteris moretonii* (Walkom) Anderson

and Anderson, comb. nov. p. 376, fig. 3; p.547, figs 5, 6.

Description

A simple strap-shaped leaf with entire or slightly lobed margins; complete leaf unknown, from 30 – 110 mm wide; lamina covering whole of mid vein; lateral veins departing from a central line above the mid vein at an acute angle immediately arching then proceeding straight and parallel to the margin. Veins frequently fork on leaving the central rib and again soon after; density 20 – 35 / 10 mm.

Nymboida Material

Known only from a single specimen, AMF130184 from Coal Mine Quarry, base and apex missing, vein density in lower portion of lamina 30 / 10 mm becoming denser distally, to 40 / 10 mm, straight and parallel at a high angle across lamina and curving slightly upwards to the margin.

Discussion

This leaf fragment is placed in *N. moretonii* on the basis of the very dense venation and its mid dorsal attachment to the mid vein.

Anderson and Anderson (1989) transferred *Nilssonia moretonii* to the genus *Taeniopteris* without additional comment. Under "Intergeneric comparisons" those authors noted that entire specimens of *Nilssonia* can hardly be effectively distinguished from *Taeniopteris* and did not use the genus *Nilssonia*. Many of the leaves placed in *Taeniopteris* (see below) show evidence of lateral attachment of the lamina but towards the dorsal edge of the mid vein. The degree of the lamina overtopping of the mid vein makes for a subjective differentiation between *Nilssonia* and *Taeniopteris* in the absence of preserved cuticle.

Genus *Taeniopteris* Brogniart 1832

Type species

Taeniopteris vittata Brongniart 1832

Taeniopteris is a form genus for simple strap-shaped leaves with entire lamina and occasionally forking lateral parallel venation running at a high angle to a prominent midrib and with unknown cuticle (Meyen 1987, Taylor and Taylor 1993, Anderson and Anderson 2003). Numerous species have been described world-wide from the Upper Carboniferous to Recent. While this leaf form is diverse and widespread it rarely occurs in abundance. Many species have been erected for Gondwana Triassic material, often based on limited or dubious specimens that do little to demonstrate the natural variation within a species. Recent papers on Triassic South American *Taeniopteris* have been useful but some species appear to be based on very few specimens (eg for Argentina, Artabe 1985, Gnaedinger and Herbst 1998. For material from Chile, Gnaedinger and Herbst (2004a) have used a statistical analysis of venation sequence for ten species of *Taeniopteris*. Triassic material from South Africa was described by DuToit (1927) and very comprehensive collections from the Molteno Formation by Anderson and Anderson (1989, 2003) who described ten species from 29 assemblages (localities) and used the "palaeodeme approach" and illustrated the range of variation in a species. From Australia there are numerous species in the literature but most have been based on fragmentary material, inadequate descriptions and have often been poorly illustrated. Rarely has the natural range of variation that may exist in a species been recognised. In our Nymboida collections taeniopterid leaves comprise c. 3% of numbered specimens. Few leaves, especially the larger forms, are found complete. Occasional bedding planes (possible sub–authocthonous assemblages) show numerous individual leaves resembling a natural autumnal-like leaf fall. In many specimens the leaf lamina appears to be dorsally attached to the midrib but without totally covering it as in *Nilssonia*.

In our Nymboida collections the majority of taeniopterid leaves fall within the range of variation as recognised by Webb (1980) from his examination of over 170 specimens, mostly from the Esk Formation for his unpublished species *Taeniopteris adunca* which is here validated using his type specimen and slightly emended diagnosis. Other rare Nymboida leaves with clearly distinguishing characters are described as the new species *T. nymboidensis*.

Sterile leaves of the enigmatic fern *Ogmos adinus* (Webb 1983, Holmes 2001) may be placed as a form species of *Taeniopteris* but are not included here.

Taeniopteris adunca J.A.Webb sp. nov.

Figures 3A–H; 4A–C; 5A–C

Selected synonomy

1892 *Taeniopteris* sp. indet. Etheridge, p. 374, Pl. 16, fig. 4.

1924 *Taeniopteris* (? *Danaeopsis*) *crassinervis* (Feistmantel) Walkom; Walkom, p. 84, Pl. 18, fig. 3.

1925 *Taeniopteris carruthersii*, Tenison-Woods; Walkom, p. 85, text fig. 3.

1965 *Taeniopteris* aff. *lentriculiforme* (Etheridge) Walkom; Hill et al., PL. T8, Fig. 4.
1975 *Taeniopteris* aff. *lentriculiforme* (Etheridge) Walkom; Flint and Gould, Pl. 3, figs 8, 9.
1980 *Taeniopteris adunca* sp. nov. Webb (unpubl.), Pl. 23, figs 1–11; text figs 51 a–i.

Diagnosis

Strap-shaped leaves, very variable in width; leaf surface rarely undulate; secondary veins always leave midrib at moderately acute angle, then quickly arch away and travel straight and parallel to the margin at 70°–90°; individual veins frequently bifurcate twice but anastomose very rarely; vein density ranging from 15 to 25 per 10 mm near the margin.

Description

Leaves elongate, strap-shaped; tapering gradually and fairly uniformly to a stout petiolate base and distally to an obtuse to acute rounded apex; very variable in size, from 9–60 mm in width and from 110 mm to >250 mm in length; lamina rarely undulate, margins entire. Midrib sometimes striate, appearing as a prominent groove or ridge, 1-2 mm wide in mid leaf and expanding basally to c. 3 mm. Leaf lamina attached to the dorsal edge of the mid vein without overlapping the dorsal surface. Lateral veins always leave the mid vein at a moderately acute angle (usually less than 45°) and arch rapidly within 1 to 2 mm then proceed straight and parallel to the margin at an angle of c. 75° – 85° and more acutely towards the apex. Veins fork close to the mid vein and then once or rarely twice across the lamina. Conjoining of the veins is rare. Density of the veins varies between populations and leaf sizes and averages c. 15–25 /10 mm near the margin.

Holotype

UQF 18836

Type locality

G. R. 380 551 Blackbutt 1: 63 360 Sheet, Esk Formation, Toogoolawah Group, Anisian–Ladinian

Illustrated specimens from Queensland

UQF18836, UQF72601, UQF18830, UQF2103, UQF72814, UQF72813, UQF72811, UQF21494, see Fig. 3.

Additional material

AMF130185, AMF130186, AMF130187, AMF-130188, AMF130189, AMF130190, AMF130191, AMF130193, AMF130194, AMF130215. All from Coal Mine Quarry, Nymboida CM.

Name derivation

aduncus, Latin, *bent inward, hooked,* referring to the abrupt curvature of the lateral veins as they leave the midrib.

Discussion

Based on the detailed study of extensive collections of fossil plant material mainly from Queensland, J.A.Webb (1980, unpublished) differentiated two commonly occurring strap-like *Taeniopteris* leaf forms mainly on the basis of the form of attachment of the lateral veins to the mid vein. *Taeniopteris carruthersii,* widespread in the Upper Triassic assemblages, has lateral veins arising straight from the midrib at a high angle, sometimes forking and running at almost right angles to the leaf margin. In *T. adunca* the leaf lamina is attached dorsally to the midrib with the lateral veins diverging from the mid vein at an acute angle, usually forking close to the base then arching and running straight to the margin at a high angle. This arching of the veins close to the mid vein is often obscured through the form of preservation during fossilization but can be revealed from close examination. While there are wide variations within the two species and some overlapping characters, Webb recognised the two species as distinct and with stratigraphic implications. *T. carruthersii* occurs in the Late Triassic Ipswich Coal Measures whereas *T. adunca* is found in the Esk Formation of Queensland and the Basin Creek Formation of the Nymboida Coal Measures, both Middle Triassic units.

T. adunca is the most commonly occurring form of *Taeniopteris* at Nymboida. On some bedding planes (see blocks AMF130190, AMF130216, AMF130193 and AMF130194) the leaves form an almost mono-specific assemblage, probably a seasonal leaf-fall. Both within and between these assemblages there is a wide variation in leaf size and shape. *T. adunca* is regarded as a species complex.

Taeniopteris parvilocus Anderson and Anderson from South Africa (Anderson and Anderson 1989) and from Chile (Herbst et al. 2005) is similar to *T. adunca* in outline and size but differs by the less dense venation (13/10 mm) that runs almost straight from the midrib and then arches upwards towards the margin. See below for comparisons with *T. nymboidensis*.

***Taeniopteris nymboidensis* Holmes and Anderson sp. nov.**

Figures 6 A, B

Diagnosis

Leaf oblanceolate, to 150 mm long, 30 mm wide; apex obtuse; lateral veins dorsally attached at acute angle to strong mid vein, widely spaced at point of attachment, c. 6/10 mm, arching through half the width of the lamina and then running straight to margin at c. 65°–70°, bifurcating in an irregular pattern, once near the base and again across the lamina; vein density in mid lamina c. 14–18/10 mm.

Description

Leaves simple, entire, oblanceolate to 150 mm long and from 25–30 mm wide, apex obtuse; strong mid vein 2 mm wide at mid lamina and tapering distally; base petiolate to >15 mm long. Lateral veins attached on dorsal edge of the mid vein, decurrent, widely spaced at point of attachment, c. 6/10 mm, arching then running straight and parallel to the margin at c. 65°–70° in mid lamina but more acute towards the base and apex. Most veins bifurcate while arching from the base and usually once again at irregular distances from the margin. The pattern of bifurcation is very irregular. Vein density in the mid lamina c. 14–18/10 mm.

Holotype

AMF130197

Type locality

Coal Mine Quarry, Nymboida, Basin Creek Formation, Nymboida Coal Measures.

Other material

AMF130198, Coal Mine Quarry.

Name derivation

nymboidensis- with reference to the type locality

Discussion

Only two slabs in the collections display this new species. The holotype is on a block on which are the remains of seven leaves, four appearing to arise from a common point but the point of attachment is not preserved (Fig. 6A). *T. nymboidensis* differs from *T adunca* by its oblanceolate shape, by the arching of the lateral veins which continues half way across the lamina and by the irregular bifurcation of the lateral veins. In shape and venation pattern *T. nymboidensis* is similar to *T. troncosoi* Gnaedinger and Herbst (2004a) but differs by the less dense venation. *T. fissiformis* Anderson and Anderson (1989) is similar to *T. nymboidensis* in vein density (15/10 mm) but is a much smaller leaf; *T. anavolans* Anderson and Anderson (1989) is similar in shape and size but has coarser venation of c. 12/10 mm.

Taeniopteris* sp *A

Figure 7B

Description

Mid portion of a very large leaf >100 mm wide; mid-vein to 5 mm wide, longitudinally striate; lateral veins attached to the dorsal edge of the mid vein at 60°–70° and quickly arch and run at c. 80° straight and parallel to each other across the lamina and curve slightly upwards towards the margin. Some of the lateral veins bifurcate close to the mid-vein and others occasionally fork at varying distances towards the margin. The vein density is ca 10–12/10 mm.

Material

AMF130199 Coal Mine Quarry.

Discussion

This fragment differs from *T. adunca* and *T. nymboidensis* by the larger size and broader mid vein and from *N. dissita* by the lateral veins not overtopping the mid vein. *Taeniopteris* sp. *A* of Anderson and Anderson (1989) from the Triassic Molteno Formation of South Africa is a very much larger leaf with a finer mid rib and lateral veins almost overtopping the mid vein. Another large leaf from the Molteno Formation, *Taeniopteris homerifolius* Anderson and Anderson (1989) has a venation pattern with veins upcurving towards the margin similar to *T.* sp. *A* but differs by the lateral attachment of the lamina to the mid-vein. Webb (1980 p. 218) described a *Taeniopteris* sp. (unpublished) with much larger leaves – to 240 mm wide and lateral veins occasionally anastomosing which he compared with a leaf from South Africa described by DuToit (1927) as *Taeniopteris lata.*

Genus *Linguifolium* Arber 1913 emend. Retallack 1980

Type species

Linguifolium lilleanum Arber 1913

Linguifolium was erected for simple entire leaves, linear, spathulate, lanceolate or obovate; apices sub-acute to rounded; with mid vein persistent to apex; lateral veins arising at very acute angle to the mid rib then arching to meet the margin at an acute angle, forking once and occasionally twice in the nearer third of their length. The status of the genus *Linguifolium* was well-discussed by Retallack (1980). *Linguifolium* leaves are extremely rare in the Nymboida collections.

Linguifolium tennison-woodsii (Jack and Etheridge 1892) Retallack 1980

Figures 8B, C

Selected synonymy

1892 *Angiopteridium tennison-woodsii*, Jack and Etheridge, p. 365

1898 *Taeniopteris tennison-woodsii*, Shirley, comb. nov. p. 23, Pl. 9, fig. 2.

1947 *Doratophyllum tennison-woodsii*, Jones and deJersey, p.37, Pl. 6, fig. 1.

1980 *Linguifolium tennison-woodsii*, Retallack, comb nov. fig. 7 F–H.

1980 *Linguifolium tennison-woodsii*, Webb, p.172, Pl. 20, figs 1–4, Pl.21, figs 1–15, text fig. 41, a–p, (unpubl.).

1989 *Linguifolium tennison-woodsii*, Anderson and Anderson, p.522, figs 1–3.

1998 *Linguifolium tennison-woodsii*, Gnaedinger and Herbst, Pl.1, fig. d.

Description

A portion of a small linear leaf with the base missing, tapering slightly distally to an incomplete apex. Length preserved 80 mm, width 6 mm. Mid vein not well defined, lateral veins decurrent on mid vein, arching across lamina to meet entire margin at c. 75°, forking once close to mid vein. Vein density in mid lamina c.12/10 mm.

Material

AMF130200, Coal Mine Quarry, Basin Creek Formation, Nymboida Coal Measures.

Discussion

Linguifolium tennison-woodsii differs from most *Linguifolium* spp. by its narrow linear form and from the extremely narrow *Linguifolium gracile* from the Molteno of South Africa (Anderson and Anderson 1989) by its more arching and denser veins.

Linguifolium parvum sp. nov. Holmes and Anderson 2010

Figures 9A–C

Diagnosis

Small spathulate sessile leaves less than 100 mm long, lateral veins decurrent on striated mid vein, arching across lamina to meet margin at acute angle, number of veins forking near base variable, very occasional veins forking and conjoining. Vein density 8–12/10 mm.

Description

Leaf spathulate; maximum length 100 mm; width from 11–20 mm, apex rounded, lamina tapering to sessile base; midrib with longitudinal striations, width at base 1.5 mm, contracting in width through length of the leaf; lateral veins decurrent, arching from mid-vein across lamina to reach the margin at an angle of 30°–45°; c. half the veins fork once close to the mid vein; occasional veins fork in the mid lamina and conjoin to form a long narrow areole. Density of the veins at mid lamina ranges from 8 to 12/10 mm.

Holotype

AMF130201

Type locality

Coal Mine Quarry, Basin Creek Formation, Nymboida Coal Measures.

Other Material

AMF130202, AMF130203, AMF130204, and AMF130207 from Coal Mine Quarry. AMF130205 and AMF130206 from Reserve Quarry.

Name derivation

parvum – Latin – small, referring to the small size of the leaves of this taxon..

Discussion

Linguifolium parvum is similar in form to *L. lilleanum* Arber (1913), *L. ascium* Webb (1980) and *L. patagonicum* Gnaedinger and Herbst (1998) but differs by the short length and by the density and course of the lateral veins. In the Nymboida collections these *Linguifolium* leaves are very rare. The generic diagnosis of *Linguifolium* states that the lateral veins do not anastomose. However on some specimens of *L. parvum* very occasional lateral veins fork and conjoin to form a long narrow areole, hardly reason to remove it from *Linguifolium*.

? *Linguifolium* sp. *A*

Figures 8D, E

Description

A small spathulate leaf somewhat resembling in shape *L. parvum,* is 74 mm long and 14 mm wide, with base and apex missing. The lateral veins are sparse, c. 8/10 mm and arch slightly across the lamina at c. 45° to each terminate at a tooth along a unique finely serrate margin; occasional veins forking once between mid vein and mid lamina.

Material

AMF130208 and counterpart AMF130209, Coal Mine Quarry.

Discussion

This form is based on a single specimen and its counterpart. It differs from all described species of *Linguifolium* by the serrate margin. *Jungites polymorpha* from the Molteno Formation (Anderson and Anderson 1989) has a finely serrate margin but differs by the dense parallel venation and the variably entire to pinnate lamina margin.

Genus *Gontriglossa* Anderson and Anderson 1989

Type species

Gontriglossa verticillata (Thomas 1958) Anderson and Anderson 1989

The genus *Gontriglossa* was erected by Anderson and Anderson (1989) for elliptic, petiolate leaves with veins attached at an acute angle, arching and anastomosing towards the margin. Some specimens of *G. verticillata* from the Molteno Formation of South Africa (Anderson and Anderson 1989, 2003) show stems with well-spaced opposite fascicles of three leaves. From Nymboida, Holmes (1992) described some reticulate veined leaves that were identified as Triassic "*Glossopteris*-like leaves". Those leaves are here transferred to the genus *Gontriglossa.* Amongst the Nymboida material is a specimen showing 10 leaves attached in a whorl or a close spiral (10A, 12A). To accommodate this form in *Gontriglossa* requires a slight emendation of the generic diagnosis to include the attachment of leaves as either terminal whorls, close spirals or well-spaced opposite fascicles.

***Gontriglossa grandis* (Walkom) Holmes and Anderson comb. nov.**

Figures 10A; 12A

Synonymy

1928 *Anthrophyopsis grandis* Walkom, p. 464, text fig. 2, Pl. 26, fig. 5.
1992 ?*Glossopteris grandis* Holmes, p. 122, Pl. 2, figs1, 2.

Description

Leaves oblanceolate, to 150 mm long, and to 95 mm wide but usually much smaller, attached as a terminal whorl or a close spiral, apex rounded acute to obtuse, tapering basally to a short petiole; midrib distinct, striate; lateral veins leave the midrib at an acute angle and for about one third of the width of the lamina they bifurcate and anastomose to form a wide elongate mesh with a general inclination of c. 45° to the midrib; for the remainder of the lamina they form a narrower elongate mesh inclined at 65°–70° to the midrib; closer to the midrib the meshes are 1–2 mm wide, wider in the proximal than the distal part, while towards the margin they narrow to form 7–8 meshes per 5 mm of width.

Holotype

UQF1724-5, University of Queensland, Brisbane from Sheep Station Creek in the Esk Beds.

Other material

AMF 78254–78258, Australian Museum, Sydney – from Coal Mine Quarry, Nymboida.

Discussion

The Nymboida leaves placed in this species are much smaller (c. 80 mm long and c. 30 mm wide) than the holotype specimen but are closely similar in gross form and the anastomosing venation pattern. The Nymboida specimens are notable for the whorled or closely spiral arrangement of the leaves. Individual leaves of *G. verticillata* (Thomas) Anderson and Anderson (2003) are similar in size and venation pattern to the Nymboida leaves but differ by the known cuticle and the well-spaced opposite attachment of fascicles of three leaves to an elongated stem.

***Gontriglossa nymboidensis* Holmes and Anderson comb. nov.**

Figures 11A, B

Selected Synonymy .

1975 *Anthrophyopsis grandis* Walkom, Flint and Gould, Pl. 1, fig. 9.
1992 *?Glossopteris nymboidensis* Holmes, P. 122, Pl. 1, figs 3,4; Pl.. 2, fig.1.

Holotype

UNEF13528 and paratype UNEF13639, both from Coal Mine Quarry. Now housed in the Australian Museum as specimens AMF126731 and AMF126730 respectively.

Additional material

AMF130214, Coal Mine Quarry.

Description

A reticulate veined leaf known only from apical

and mid lamina fragments. Leaf of unknown length, width 50 mm, tapering distally to an acutely rounded apex; midrib distinct, striated; lateral veins leaving midrib at c. 20°–30° at intervals of ca 0.5 mm and quickly arch over a distance of c. 5 mm where they bifurcate and then run straight to the margin at an angle of 75°. After the initial bifurcation the veins fork again two or three times to join with adjacent veins to form long narrow meshes, each subsequent mesh being narrower than the proceeding one. The density of the veins in the mid lamina is c. 12–14/ 10 mm and at the margin c. 18/10 mm.

Additional material

AMF130214, Coal Mine Quarry.

Discussion

G. nymboidensis differs from all other *Gontriglossa* species by the very fine narrow parallel meshes formed by the lateral veins. *Cetiglossa balaena* Anderson and Anderson (2003) from the Molteno of South Africa is much larger leaf with more elongate reticulate venation that does not arch from the mid vein. The somewhat similar reticulate veined leaf from Patagonia, *Santacruzia hunickenii* Gnaedinger and Herbst (1998) differs by the serrate to incised margins and the lateral veins attached at a high angle and running straight to the margin. (See comparison of *Santacruzia hunickenii* with *Gontriglossa lacerata* below).

***Gontriglossa lacerata* (Holmes 1992) Holmes and Anderson comb. nov.**

Figures 11C, D

Synonymy

1992 ?*Glossopteris lacerata* Holmes, p. 124, Pl. 2,4.

Holotype

AMF78259. Coal Mine Quarry, Basin Creek Formation, Nymboida Coal Measures.

Additional material

AMF130210 and AMF130213 from Reserve Quarry

Description

Known from three incomplete specimens. Leaf broad-elliptic or oblanceolate, >180 mm long, 65 mm wide, petiolate; apex broadly rounded; margin irregularly lacerate, dentate or lobed; venation somewhat similar to *G. nymboidensis*, arching from mid-vein, bifurcating and anastomosing to the margin.

Discussion

This is a bizarre species. It differs from other *Gontriglossa* species by the irregularly lacerate margins which we believe to be natural and not resulting from insect damage.

Gnaedinger and Herbst (1998) described from the Triassic Tranquilo Group of Santa Cruz, Argentina a leaf with reticulate venation and serrate to deeply incised margins and placed it in their new genus and species *Santacruzia hunickenii*. They were perhaps unaware of the paper by Holmes (1992) as they made no comparisons with *?Glossopteris* (now *Gontriglossa) lacerata. S. hunickenii* differs from *Gontriglossa retculata* by the less deeply incised margin and by the much denser venation that passes at 90° from the mid-vein to the margin. Gnaedinger and Herbst did compare *Santacruzia* with the Molteno species *Gontriglossa balaena* that has been transferred to the genus *Cetiglossa* Anderson and Anderson (2003) which lacks the lacerate lamina margin.

***Gontriglossa ligulata* Holmes and Anderson sp. nov.**

Figures 12B–D

Diagnosis

Leaf ligulate, lateral veins decurrent on mid vein, widely spaced, arching and bifurcating once then running straight at a high angle towards the margin; forking again in mid lamina and conjoining to form a longitudinal row of transverse rhomboidal areoles and a row of triangular areoles parallel and adjacent to the margin.

Description

An incomplete strap-shaped leaf 80 mm long but with base and apex missing; lamina 14 mm wide above broken base, tapering gradually over whole length to 8 mm; mid vein 1 mm wide; lateral veins decurrent and widely spaced on mid vein, arching and bifurcating once then passing to margin at c. 75°. Between mid lamina and margin each vein bifurcates twice and anastomoses with adjacent veins to form a longitudinal row of transverse rhomboidal areoles and a row of triangular areoles parallel to the margin; vein density near margin c. 16/10 mm.

Holotype

AMF130211

Type Locality

Reserve Quarry, Nymboida, Basin Creek Formation, Nymboida Coal Measures.

Name derivation

ligulata – Latin, *strap-shaped*, referring to the broad-linear form of the leaf.

Discussion.

This new species is based on a single incomplete specimen. While recognising that some species of *Taeniopteris*, eg *T. fissiformis* and *T. anavolans* (Anderson and Anderson 1989; Gnaedinger and Herbst 2004a) may show rare and irregular anastomoses, we believe that from the regular and distinctive anastomosing venation (see Fig. 12D) this leaf is best placed in *Gontriglossa,* The linear shape of the leaf and the details of the anastomosing venation pattern differentiate *G. ligulata* from the other *Gontriglossa* species described above and from the cordate based leaf, *G. hilaryjanea* (Anderson and Anderson 1989, 2003). The regular form of the marginal areoles diffentiates *G. ligulata* from the *Scoresbya* sp. described below.

Genus *Scoresbya* Harris 1932

Type species

Scoresbya dentata Harris 1932

Scoresbya dentata was described by Harris (1932) for small palmate leaves with reticulate venation and dentate margins from Scoresby Sound in the Jurassic of Greenland. Additional specimens of *Scoresbya dentata* have been described from the Jurassic of Germany (Krausel and Schaarschmidt 1968), from China (Cao 1982), Afghanistan and Iran (Schweitzer and Kirchner 1998) plus an additional species from the Late Triassic of Mexico (Weber 1995). An incomplete specimen showing parts of several segments of a palmate leaf with dentate margin and reticulate venation from the Ipswich Coal Measures of Queensland was described by Shirley (1898) as *Phlebopteris* (?) *dichotoma* and later transferred by Herbst (1974) to the *Scoresbya* genus.

Scoresbya carsburgii Holmes and Anderson sp. nov.

Figures 13A, 14A, B.

Diagnosis

A large leaf bifurcating irregularly into broad linear lobes; margins entire to irregularly serrulate; lateral veins decurrent on striate mid vein, then arching and running to margin, forking near base, occasionally in mid lamina and then forking and sometimes conjoining to form small areoles adjacent to the margin; vein density in mid lamina c. 12 / 10 and c. 18 / 10 mm near margin.

Description

An incomplete palmate leaf; mid vein longitudinally striated, 3 mm wide in proximal section of leaf; lamina bifurcating at 10 mm from the base of leaf as preserved. The minor fork produces a broad linear pinna or lobe 90 mm long and 28 mm wide. After 43 mm the main rachis again bifurcates to form a major elongate lobe (pinna) 120 mm long and 30 mm wide and a minor lobe 60 mm long and 20 mm wide, both tapering slightly distally. The margins of the lobes are entire to irregularly undulate or serrulate. Throughout the leaf the decurrent lateral veins are widely spaced as they arch at an acute angle from the main rachis, soon forking irregularly and then running straight to the margin at c. 30°–45°, again sometimes forking at irregular distances across the lamina; close to the margin some veins again fork and conjoin to form small triangular areoles adjacent and parallel to the margin (Fig. 14B). Density of the lateral veins in mid lamina c 12/10 mm and near the margin c 18/10 mm.

Holotype

AMF130212

Type Locality

Reserve Quarry, Nymboida, Basin Creek Formation, Nymboida Coal Measures.

Name derivation

carsburgii – named for the collector of the specimen, amateur fossil plant and insect enthusiast, Mr Allan Carsburg.

Discussion

Scoresbya carsburgii is based on a single incomplete specimen that overlies another lobe fragment. It differs from the northern hemisphere species *S. dentata* Harris by its larger size, less obvious dentate or pinnatifid margins and by the form of venation. *Scoresbya dichotoma* (Shirley) Herbst (1974) from the Ipswich Coal Measures of Queensland is a smaller leaf and as described by Herbst has veins conjoining to form an intramarginal vein similar to that in the genus *Yabiella.* From the late Triassic of Chile *Mollesia melandeziae* Melchior and Herbst (2000) is described as particularly similar to *Scoresbya* but with a different venation pattern. The affinities of *Scoresbya* are not well understood. Herbst (1992) excluded *Scoresbya* from

the Dipteridaceae and Taylor et al (2009) discussed it under the Caytoniales while Weber (1995) inferred a possible link with angiosperms. *S. carsburgii* is an interesting addition to the Nymboida flora and illustrates the many puzzles still to be solved in these ancient floras.

CONCLUSION

This paper deals with leaves of simple form placed in the form genera *Nilssonia, Taeniopteris, Linguifolium* and *Gontriglossa* and a unique lobed leaf referred to the genus *Scoresbya*. Described are two species of *Nilssonia* including a new species *N. dissita;* three species of *Taeniopteris* including the new species *T. adunca* and *T. nymboidensis*; two species of *Linguifolium* including the new species *L. parvum*; four species of *Gontriglossa* including three new combinations and a new species *G. ligulata*. A unique specimen of a lobate leaf is described as *Scoresbya carsburgii* sp. nov.

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Figure 1. A–C. *Nilssonia dissita* Webb sp. nov. A. GSQF12897, Holotype, GSQ Locality 1552, Esk Fm. B. GSQF12898, GSQ Locality 1552, Esk Fm. C. AMF130181 Coal Mine Quarry, Nymboida CM. Scale bar = 1 cm.

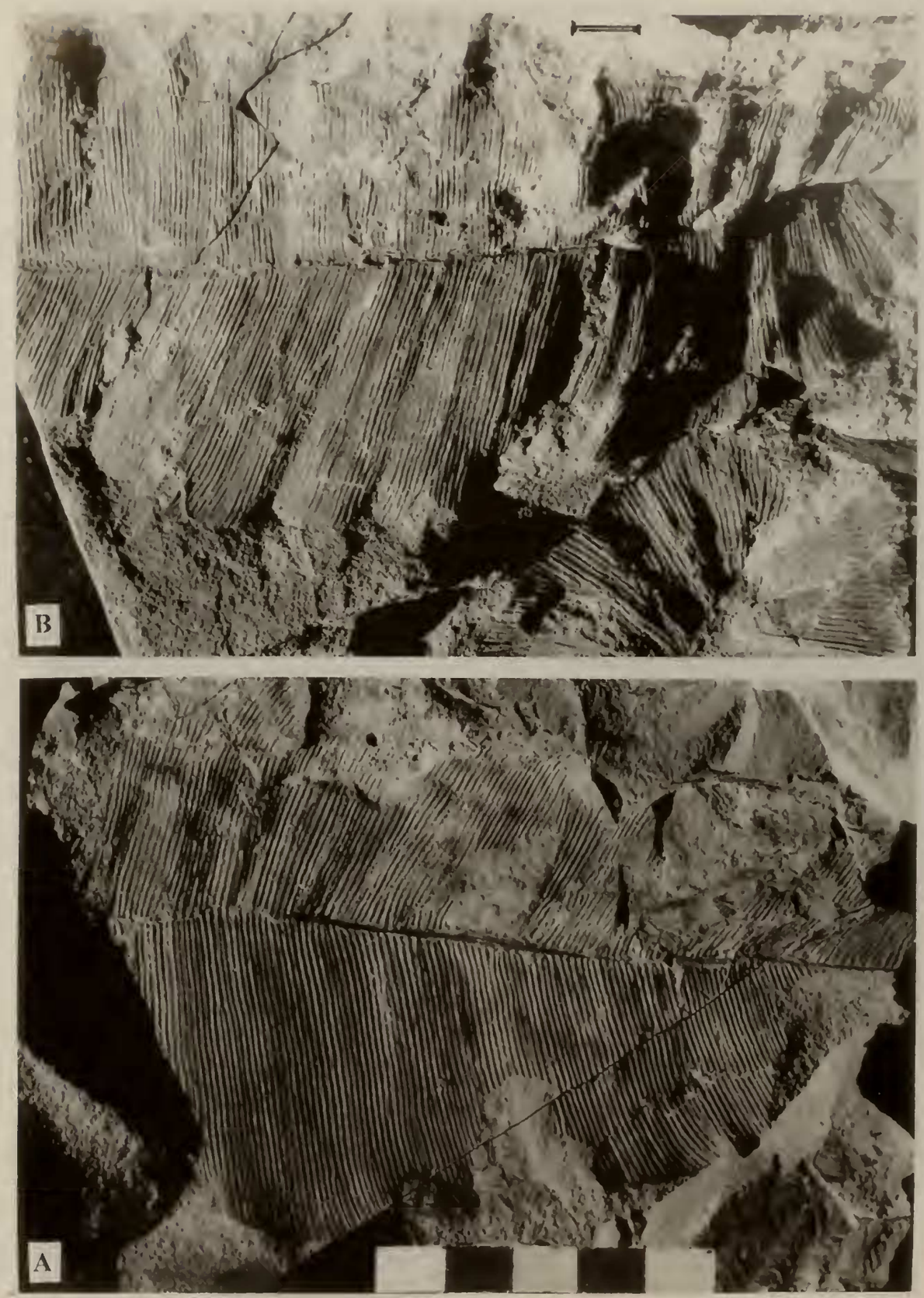

Figure 2. A. B. *Nilssonia dissita* Webb sp. nov. A. AMF130182, Coal Mine Quarry. Scale bar = 5 cm. B. AMF130180, Coal Mine Quarry, Nymboida CM. Scale bar = 1 cm.

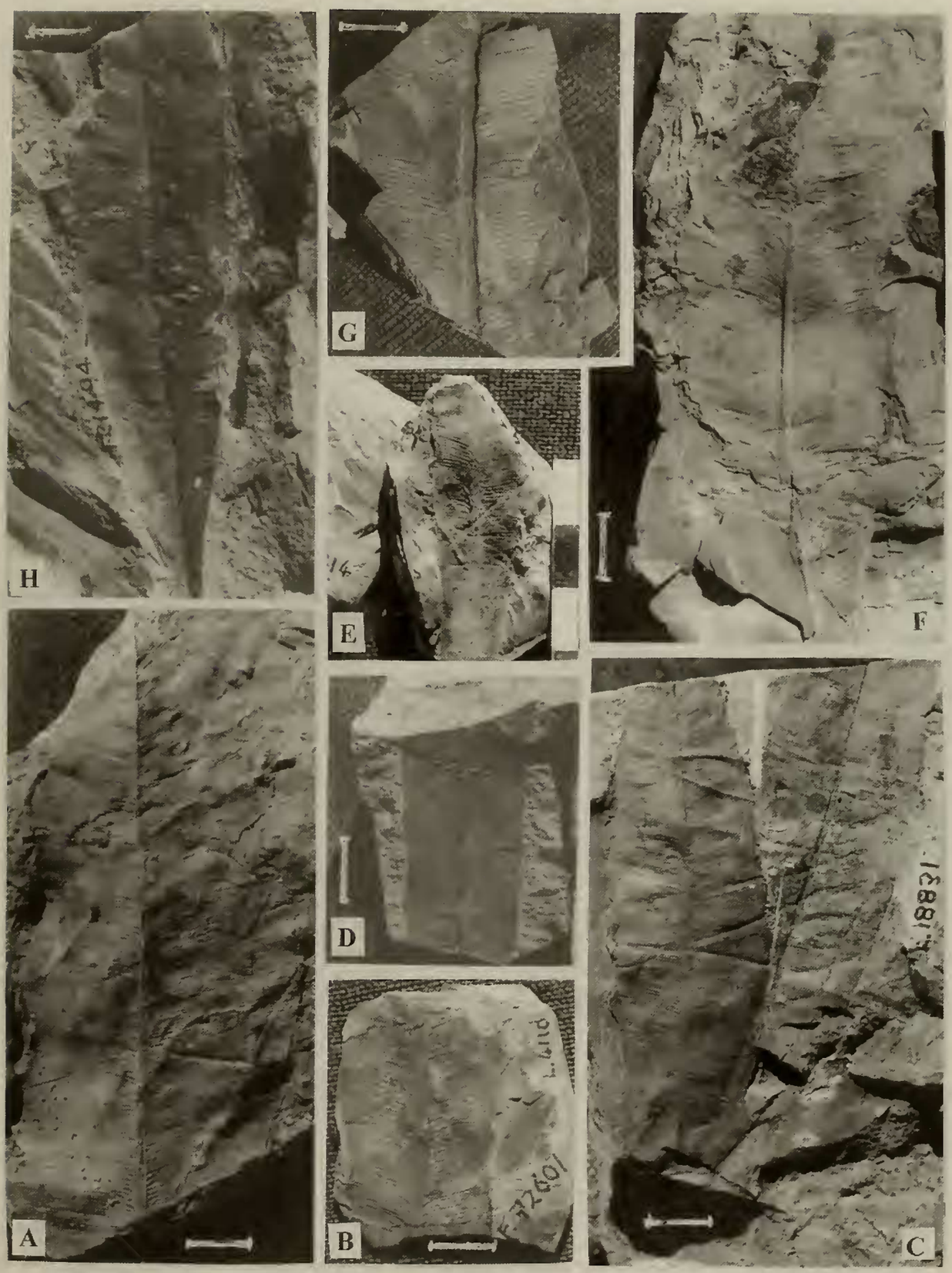

Figure 3. A–H. *Taeniopteris adunca* Webb sp. nov. A. UQF18836, Holotype. 380 551 Blackbutt Sheet. B. UQF72601, UQL4110. C. UQF18830, 445 486 Blackbutt Sheet. D. UQF2103. UQL4238. E. UQF72814, UQL4255. F. UQF72813, UQL4238. G. UQF72811, UQL4110. H. UQF21494, UQL585. All from Esk Fm. Scale bar = 1 cm

Figure 4. A–C. *Taeniopteris adunca* Webb sp. nov. AMF130194, Reserve Quarry. B. AMF130195, Coal Mine Quarry. C. AMF130186, Coal Mine Quarry. All Nymboida CM. Scale bar A, C = 1 cm, B = 5 cm.

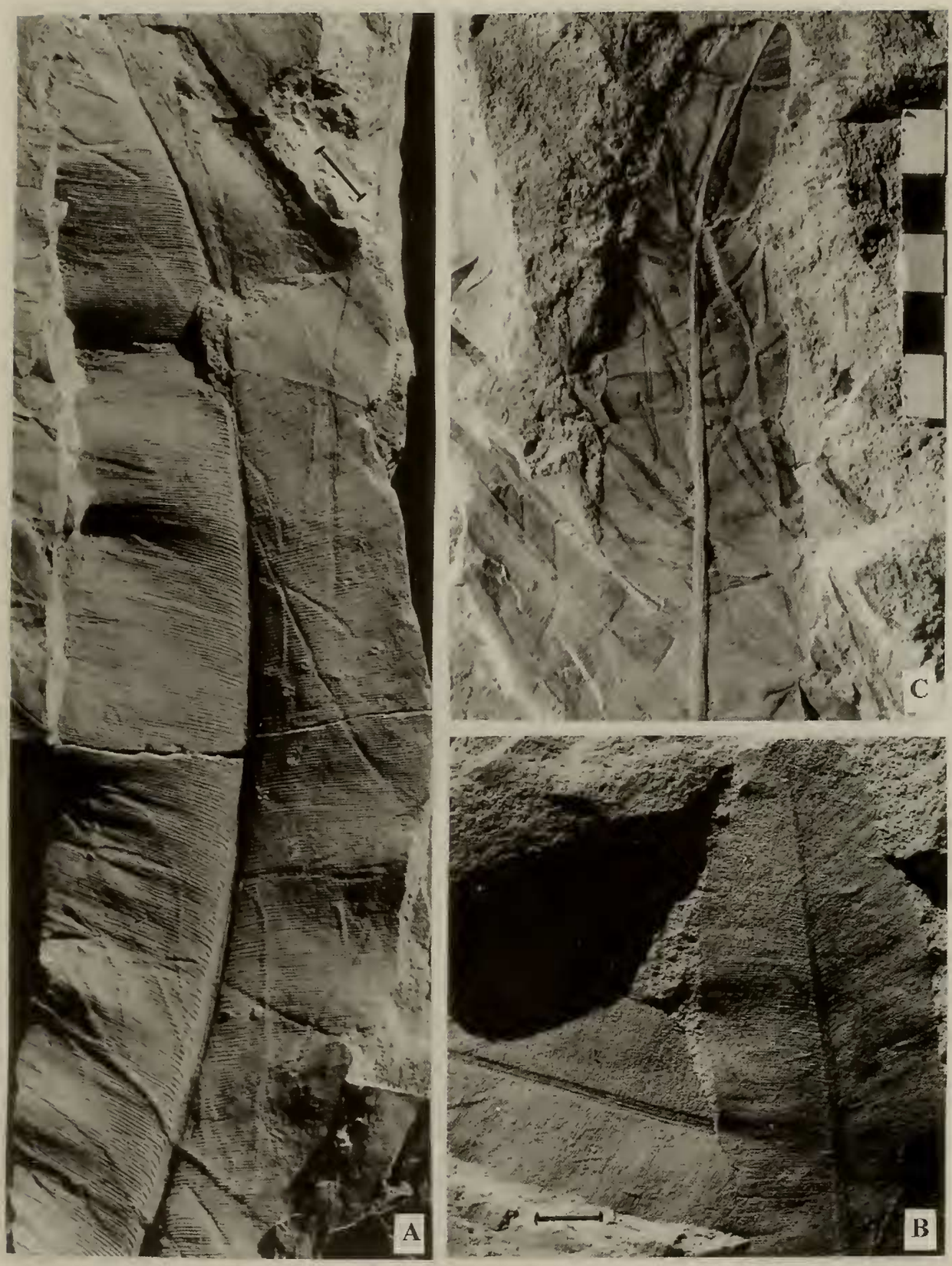

Figure 5. A – C. *Taeniopteris adunca* Webb sp. nov. A. AMF130187. B. AMF130189. C. AMF130196, all from Coal Mine Quarry. Nymboida CM. Scale bar A, B = 1 cm. C = 5 cm.

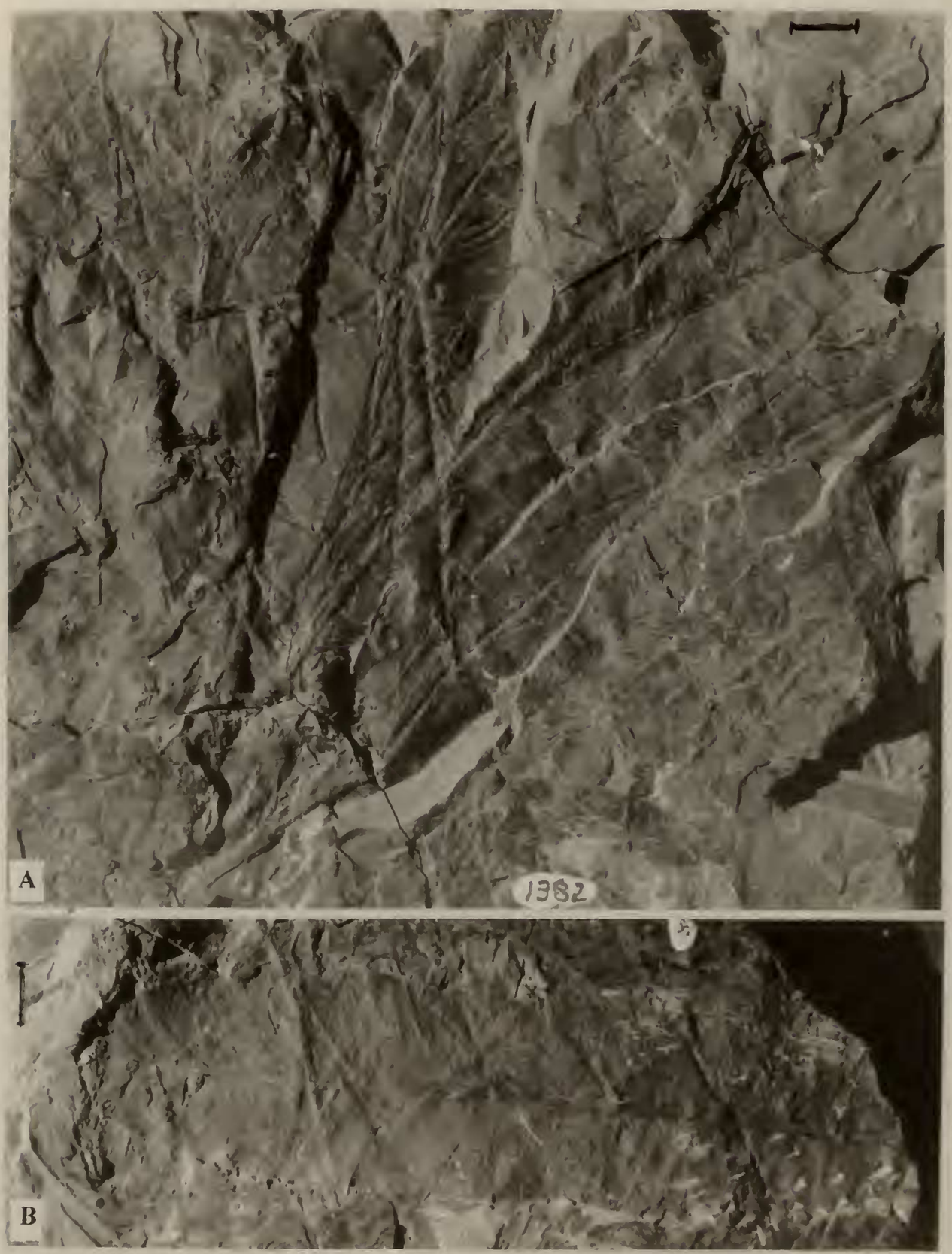

Figure 6. A, B. *Taeniopteris nymboidensis* Holmes and Anderson sp. nov. A. AMF130197. B. AMF130198, both from Coal Mine Quarry. Nymboida CM. Scale bar = 1 cm.

Figure 7. A, B. *Nilssonia dissita* Webb sp. nov. AMF120939. B.Taeniopteris sp A. AMF 130199, both Coal Mine Quarry. Nymboida CM. Scale bar = 1 cm.

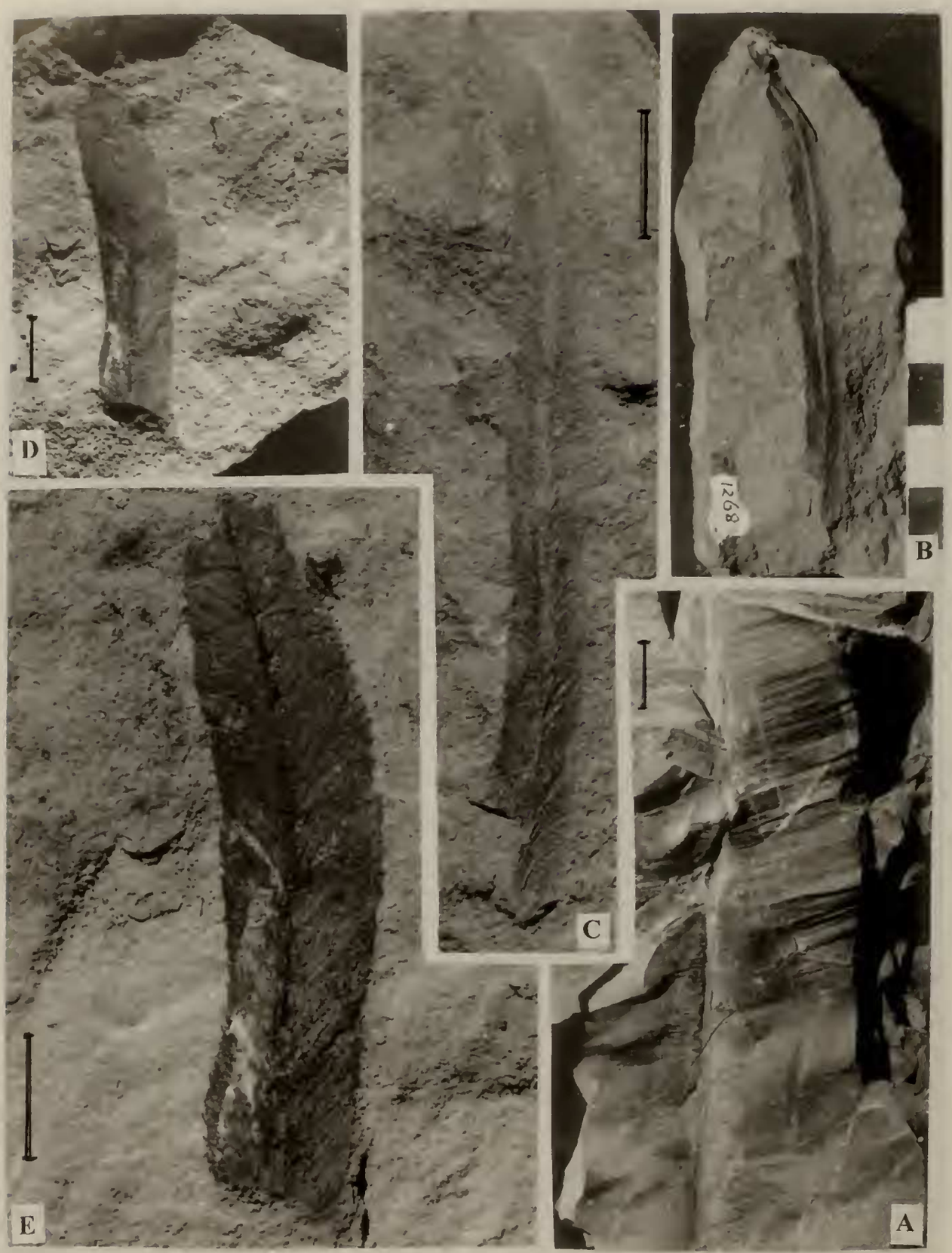

Figure 8. A. *Nilssonia moretonii* AMF130184. B, C. Linguifolium tennison-woodsii AMF130200. D, E. Linguifolium sp A AMF130208. Numboida CM. Scale bar A, C, E = 1 cm, B = 5 cm.

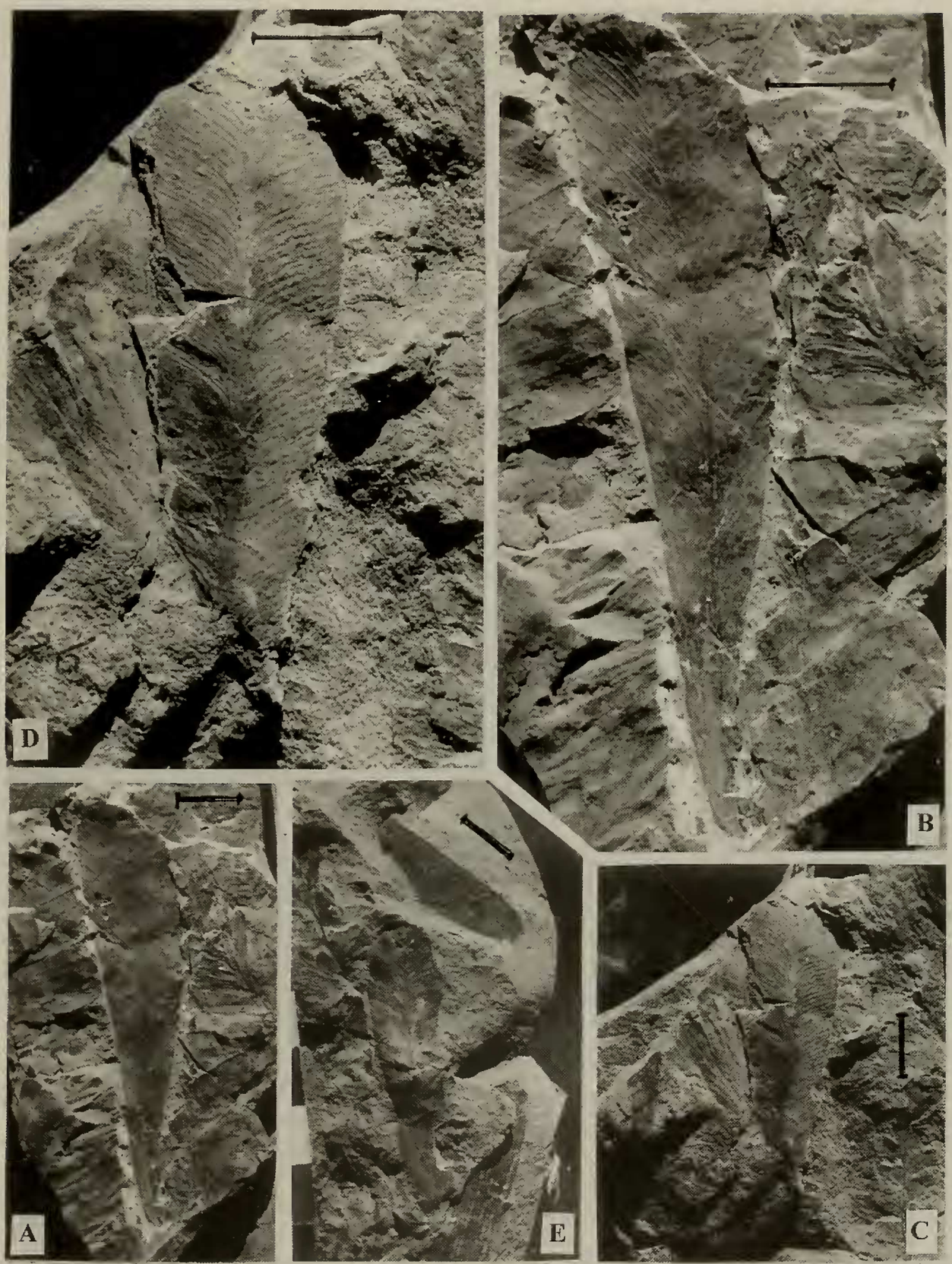

Figure 9. A – E. *Linguifolium parvum* Holmes and Anderson sp. nov. A, B. Holotype AMF130201, Coal Mine Quarry. C, D. AMF130207, Coal Mine Quarry. E,. AMF130206, Reserve Quarry. Nymboida CM. Scale bar = 1 cm.

Figure 10. A. *Gontriglossa grandis* (Walkom) Holmes and Anderson comb. nov. Holotype AMF 78254 Coal Mine Quarry. Nymboida CM. Scale bar = 1 cm.

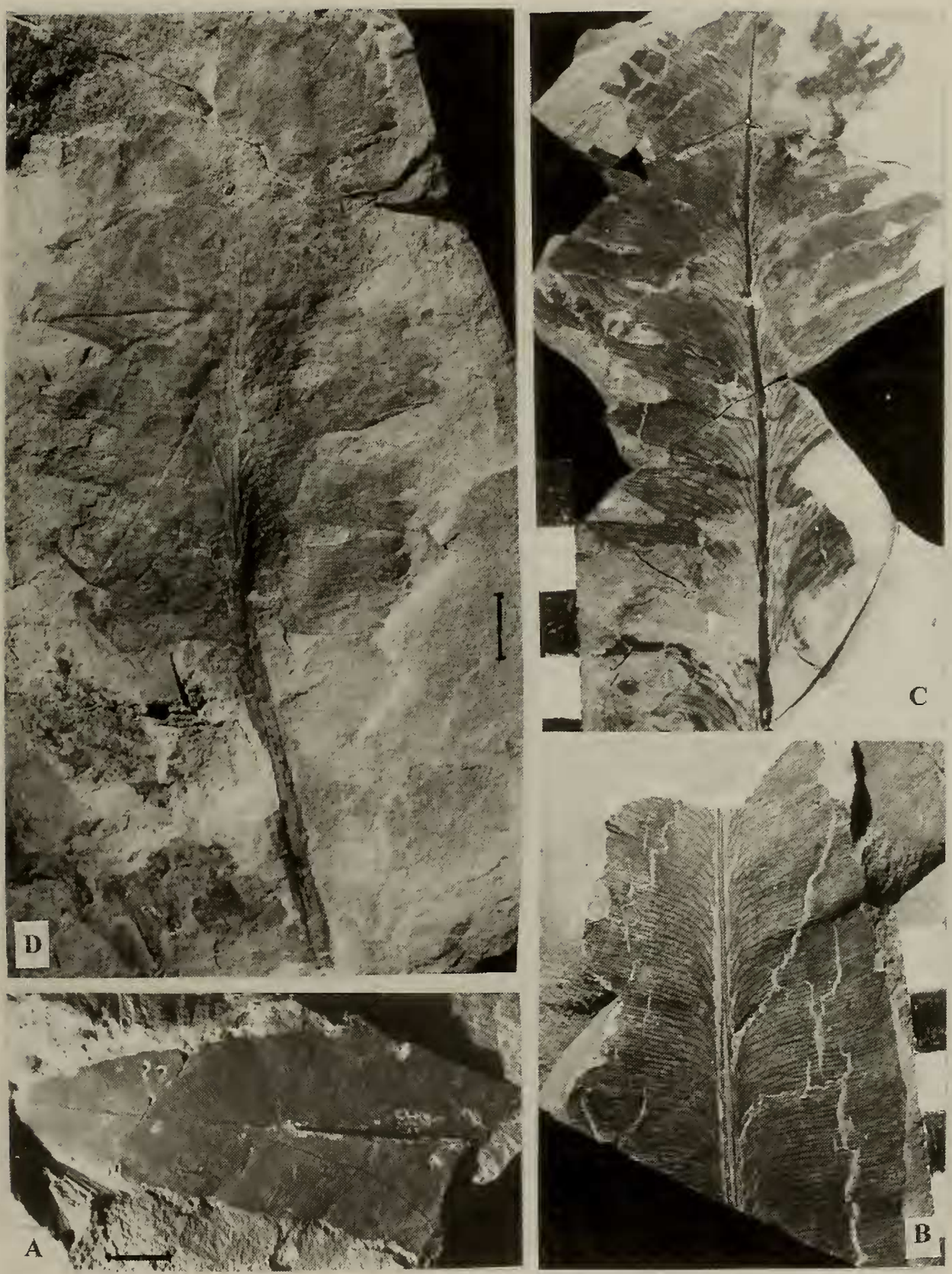

Figure 11. A, B. *Gontriglossa nymboidensis* (Holmes) Holmes and Anderson comb. nov. A. Holotype AMF126730. Coal Mine Quarry. B. Paratype AMF126731. Coal Mine Quarry. C, D. *Gontriglossa lacerata* (Holmes) Holmes and Anderson comb. nov. C. Holotype AMF78259 Coal Mine Quarry.. D. AMF130210, Reserve Quarry. Nymboida CM. Scale bar = 1 cm.

Figure 12. A. *Gontriglossa grandis* (Walkom) Holmes and Anderson comb. nov. AMF78254 Coal Mine Quarry. B –D. Gontriglossa ligulata Holmes and Anderson sp. nov. AMF130211, Reserve Quarry. Nymboida CM. Scale bar = 1 cm.

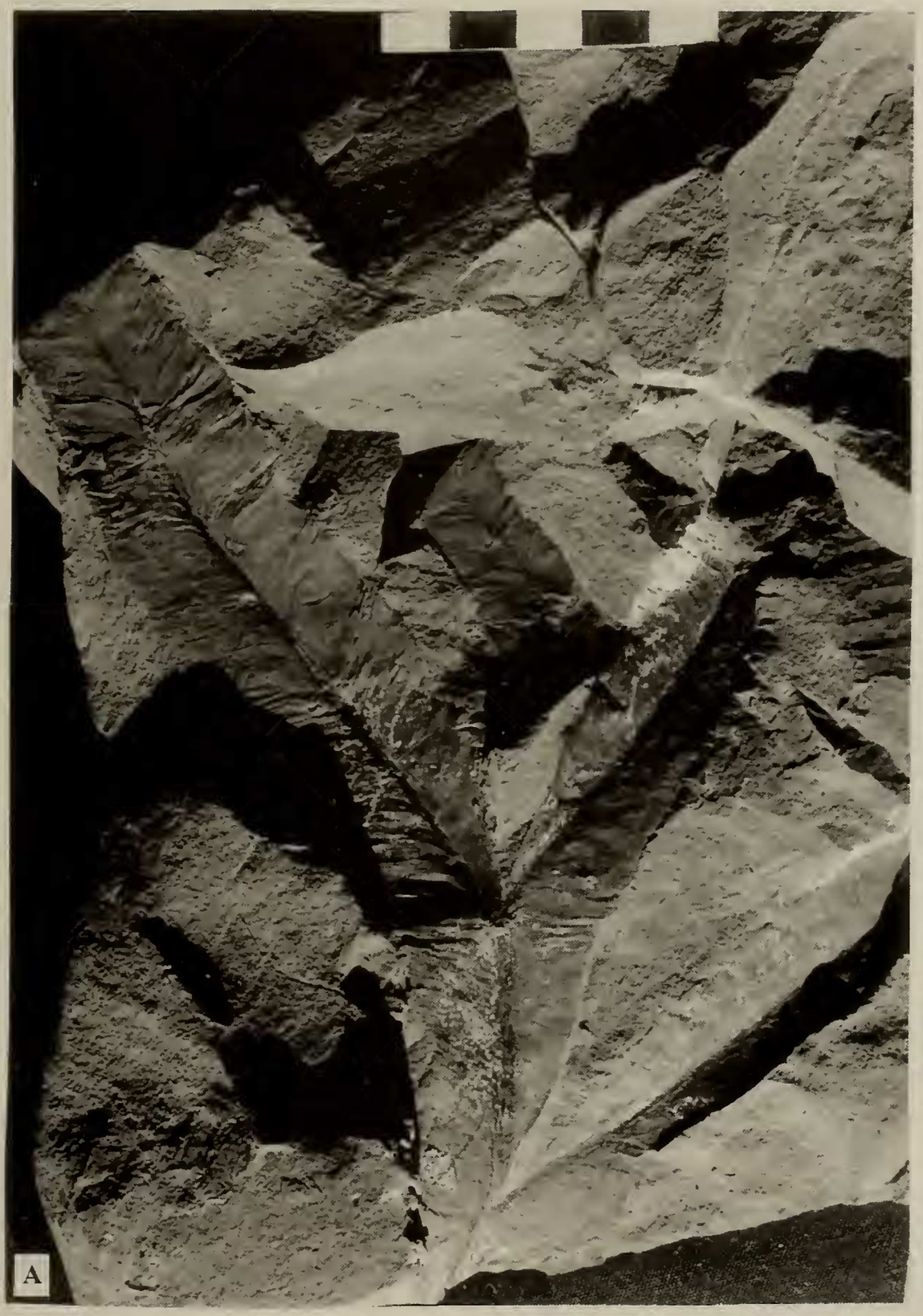

Figure 13. A. *Scoresbya carsburgii* Holmes and Anderson sp. nov. Holotype AMF130212, Reserve Quarry. Nymboida CM. Scale bar = 1 cm.

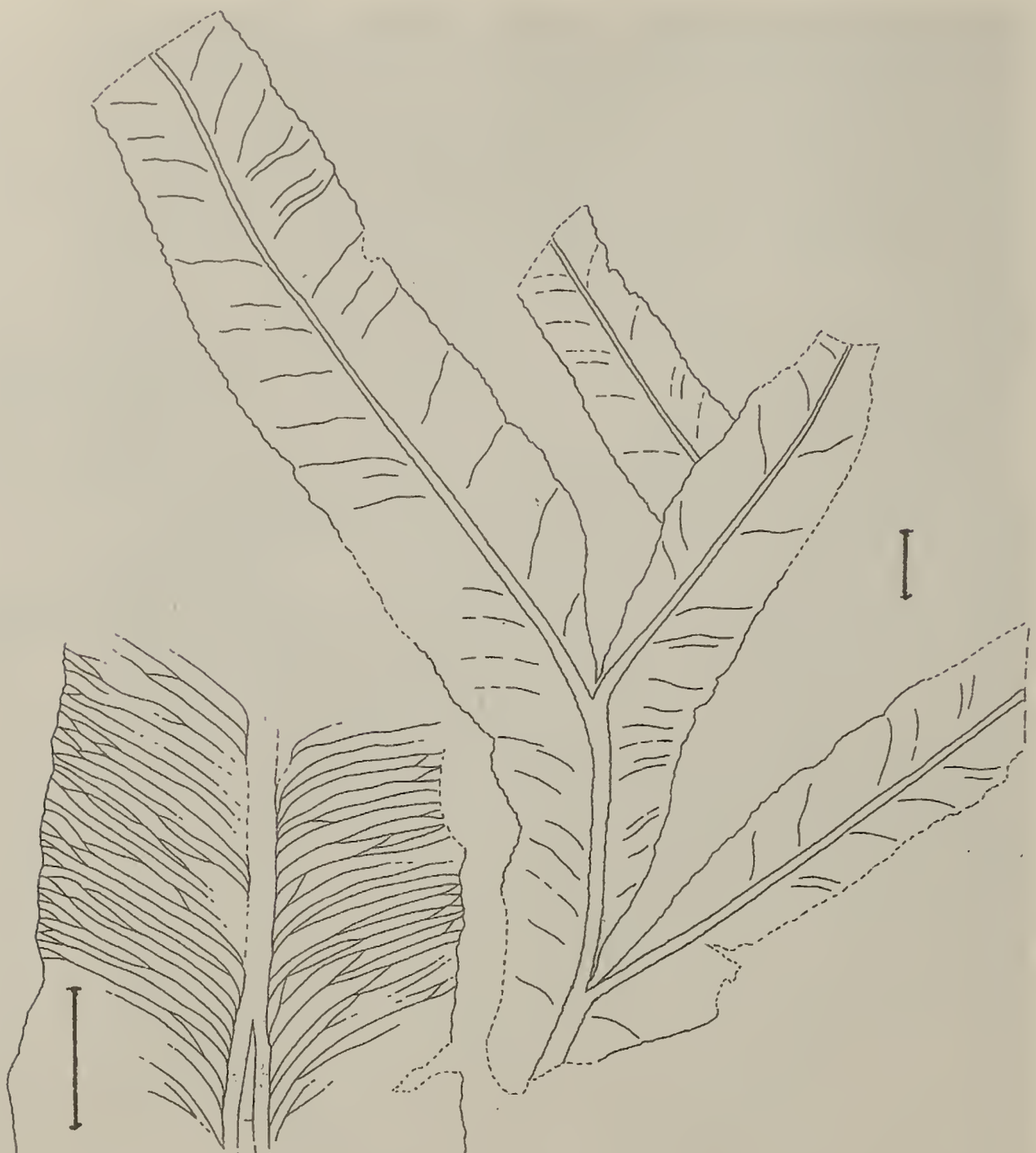

Figure 14. A, B. *Scoresbya carsburgii* Holmes and Anderson sp. nov. A. Line drawing of Holotype. AMF130212. B. Details of venation. Scale bar = 1 cm.